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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	09/846,718	CHEN ET AL.
	Examiner	Art Unit
	Kevin Siangchin	2623

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-36* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *7,9 and 30* is/are allowed.

6)☒ Claim(s) *1-6, 8, 15-29 and 32-35* is/are rejected.

7)☒ Claim(s) *10-14, 31 and 36* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *01 May 2001* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *2-3*.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

Detailed Action

Drawings

Objections

1. The drawings are objected to because of the following.

   a. The text in steps 206 and 216 of Fig. 2 are blurred. This may prevent a proper reproduction of Fig. 2.

   b. Step 404 of Fig. 4(b) contains the text *none-iris pixels.* From the disclosure it is evident that the Applicant intended this text to be *non-iris pixels.* Fig. 4(b) should be changed to reflect this.

   c. Correction should be made to step 501 of Fig. 5 so that the text within the box representing step 501 reads, *Iris Color Pixel Cluster Validation.*

   d. According to lines 26-28 on page 12 of the Applicant's specification, reference numbers 604 and 606 of Fig. 8 are to indicate a left half region and a right half region, respectively. However, as drawn, these reference numbers to not clearly illustrate this.

A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Claims

Rejections Under 35 U.S.C. § 112(2)

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

4. Claims 2 and 12 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. These claims propose performing a color histogram equalization of the digital face image based on a *mean intensity analysis*. Mean intensity analysis is apparently not a well-known procedure. No further details regarding such an analysis can be garnered from the Applicant's specification. As a result, claiming to perform equalization based on mean intensity analysis renders claims 2 and 28 indefinite. The limitation of performing histogram equalization based on a mean intensity analysis will not be considered here. Rather, item (a) of claims 2 and 28 will be interpreted, henceforth in this document, as:

(a) performing a color histogram equalization of the digital face image.

Rejections Under 35 U.S.C. § 102(e)

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

6. Claims 1, 5, 16-18, 21, 23-27, 29, 33, and 35 are rejected under 35 U.S.C. 102(e) as being anticipated by Hong et al. (U.S. Patent 6,633,655).

7. *The following is in regard to Claim 1.* Hong discloses a method for detecting a human face and tracking an observer. This method involves the detection and location of various facial features, including a pair of eyes and a mouth. Hong et al.'s method comprises the steps of:

a. Detecting a plurality of iris colored pixels in the digital face image (e.g. column 6, lines 33-35 of Hong et al.).

b. Grouping the plurality of iris colored pixels into iris pixel clusters[1] (e.g. *eye pupil regions* – column 6, lines 33-35 of Hong et al.).

c. Detecting eye positions (e.g. centroids – column 6, lines 33-35 of Hong et al.) using the iris pixel clusters.

d. Identifying salient pixels image (e.g. pixels constituting *uniform blobs* – step S23 of Hong et al. Fig. 23 and column 11, lines 49-50) relating to a facial feature in the digital face. Pixels forming the uniform blobs later are used to define regions corresponding to the subjects face and facial features. These are prominent (have uniform saturation corresponding to the properties of human skin – Hong et al. column 11, lines 25-26) with respect to the rest of the image, and can, therefore, be regarded as *salient.*

e. Generating a signature curve (i.e. vertical and/or horizontal integral projections – e.g. *V(x)* in Hong et al. column 15) using the salient pixels. See Fig. 16 and column 19, lines 34-53 of Hong et al.

f. Using the signature curve and the eye positions to locate a mouth position. See column 19, lines 34-53 of Hong et al.

It has thus been shown that Hong et al.'s method of human face detection and tracking is digital image processing method that conforms to all aspects of the method claimed in Applicant's claim 1. Therefore, the teachings of Hong et al. anticipate the digital image processing method claimed in Applicant's claim 1.

8. *The following is in regard to Claim 5.* As shown above, Hong et al. teach a method that is in accordance with claim 1. The method taught by Hong et al. further comprises the step of validating the iris pixel clusters (e.g. measuring its horizontal symmetry with respect to a center line – see Hong et al. Fig. 16, column 15 lines 12-15 and column 16, lines 10-23; or measuring the separation of iris (eyes) – see Hong et al. column 15, lines 59-67). In this way, the teachings of Hong et al. anticipate the digital image processing method claimed in Applicant's claim 5.

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1 Note that in this document Hong et al.'s eye pupil regions or eye regions (Hong et al. Abstract or Fig. 21) will be interpreted as being analogous to the Applicant's claimed iris pixel clusters. Therefore, for the remaining portions of this document these terms will be referred to interchangeably with iris pixel clusters.

9. *The following is in regard to Claim 16.* As shown above, Hong et al. teach a method that is in accordance with claim 1. In addition, the method Hong et al. generates a signature curve by projecting the salient pixels onto a vertical axis (e.g. the horizontal integral projections $H_L(y)$ and $H_R(y)$). See Hong et al. column 17, lines 4-20 and Fig. 20B. Therefore, the teachings of Hong et al. anticipate the digital image processing method claimed in Applicant's claim 16.

10. *The following is in regard to Claim 17.* As shown above, Hong et al. teach a method that is in accordance with claim 1. In addition, the method Hong et al. finds the peaks of the vertical (and horizontal) integral projections (e.g. the signature curve(s)). See, for example, step S42 of Fig. 18 of Hong et al. Therefore, the teachings of Hong et al. anticipate the digital image processing method claimed in Applicant's claim 17.

11. *The following is in regard to Claim 18.* As shown above, Hong et al. teach a method that is in accordance with claim 17. The step of finding peaks of the signature curve (corresponding to the mouth – Hong et al. Fig. 24), in the method of Hong et al., further includes:

(18.a.) Separating the digital face image into an upper half region (e.g. upper rectangular region illustrated in Fig. 24 of Hong et al.) and a lower half region (e.g. rectangle A′B′C′D′ illustrated in Fig. 24 of Hong et al.). Designating these regions as *upper half* and *lower half*, respectively, is arbitrary.

(18.b.) Finding the peak of the signature curve disposed within the lower half region. Again, referring to Fig. 24 of Hong et al., the peak of the signature curve is Y_P or X_P, depending which of the curves depicted is chosen as the signature curve.

In this way, the teachings of Hong et al. anticipate all limitations of claim 18.

12. *The following is in regard to Claim 21.* As shown above, Hong et al. teach a method that is in accordance with claim 1. The step of using the signature curve and the eye positions, in the method of Hong et al. (see claim 1, step (f) above), to locate a mouth position comprises the steps of:

(21.a.) Determining a horizontal coordinate (i.e. X_1, X_P, and X_2) of the mouth. See Fig. 24 of Hong et al.

(21.b.) Using a bottom peak position (i.e. Y_P) on the signature curve as a vertical coordinate of

the mouth. See Fig. 24 of Hong et al.

It has thus been shown that the teachings of Hong et al. address all limitations of claim 21. Therefore, Hong et al. anticipates the method of claim 21.

13. *The following is in regard to Claim 23.* As shown above, Hong et al. teach a method that is in accordance with claim 1. The method of Hong et al. further comprises the step of validating the eyes (e.g. eye symmetry with respect to a center line – Hong et al. column 16, lines 10-23) and mouth position (e.g. Hong et al. column 20, lines 5-15). It has thus been shown that the teachings of Hong et al. address all limitations of claim 23. Therefore, Hong et al. anticipates the method of claim 23.

14. *The following is in regard to Claim 24.* As shown above, Hong et al. teach a method that is in accordance with claim 23. The step of validating the eyes and mouth position comprises the steps of obtaining statistics relating to relative positions of eyes and mouth and validating the eyes and mouth position using the statistics. See Hong et al. column 20, lines 5-15. It has thus been shown that the teachings of Hong et al. address all limitations of claim 24. Therefore, Hong et al. anticipates the method of claim 24.

15. *The following is in regard to Claim 25.* As shown above, Hong et al. teach a method that is in accordance with claim 23. Furthermore, the step of validating the eyes and mouth position, in the method of Hong et al., comprises the steps of:

(25.a.) Grouping the salient pixels surrounding the mouth position to define a mouth salient pixel cluster. See Hong et al. column 19, lines 25-34 and Fig. 24.

(25.b.) Calculating a distance (i.e. $|X_2 - X_1|$ – Hong et al. Fig. 24 and column 19, line 15) between a left boundary and a right boundary of the mouth salient pixel cluster

(25.c.) calculating a distance (i.e. D_{eye} – Hong et al. Fig. 24 and column 19, line 15) between the eyes positions.

(25.d.) Determining a first ratio of $|X_2 - X_1|$ to D_{eye}. This is implicit to Hong et al.'s method, given the relationship of the rectangular area A′B′C′D′ to D_{eye}. (Hong et al. column 19, lines 15-24) and the expression in Hong et al. column 19, line 60. See also Hong et al. Fig. 24.

(25.e.) Determining whether the first ratio is within a predetermined first range. This follows from the previous discussion with respect to step (21.d) and the expression in Hong et al. column 19, line 60.

It has thus been shown that the teachings of Hong et al. address all limitations of claim 25. Therefore, Hong et al. anticipates the method of claim 25.

16. *The following is in regard to Claim 26.* As shown above, Hong et al. teach a method that is in accordance with claim 25. In the method of Hong et al., the step of validating the eyes and mouth position further comprises the steps of:

(26.a.) Calculating a distance D_{ME} between an eye level position and a mouth level position. See Hong et al. Fig. 24 and column, lines 64-67.

(26.b.) Determining a second ratio of D_{eye} to D_{ME}. See Hong et al. column 20, lines 6-15.

(26.c.) Determining whether the second ratio is within a predetermined second range. See Hong et al. column 20, lines 6-15.

It has thus been shown that the teachings of Hong et al. address all limitations of claim 26. Therefore, Hong et al. anticipates the method of claim 26.

17. *The following is in regard to Claim 27.* It was shown in the preceding discussion, relating to claim 1, that the teachings of Hong et al. address items (a)-(e) and (g) of claim 27 (where items (a)-(e) of claim 1 correspond to items (a)-(e) of claim 27 and item (f) of claim 1 corresponds to item (g) of claim 27). In addition to these steps (a)-(f), the method of Hong et al. further comprises the steps:

f. Finding the peaks of the signature curve. See, for example, Hong et al. column 19, lines 41-45.

h. Validating the eyes and mouth position. See, for example, Hong et al. column 6, lines 65-67 to column 7, lines 1-2.

Taking into account the previous discussion relating to claim 27, it has thus been shown that Hong et al.'s method of human face detection and tracking is digital image processing method that conforms to all aspects of the method claimed in Applicant's claim 27. Therefore, the teachings of Hong et al. anticipate the digital image processing method claimed in Applicant's claim 27.

18. *The following is in regard to Claims 29 and 33.* As shown above, Hong et al.'s method of human face detection and tracking is digital image processing method that conforms to all aspects of the method claimed in Applicant's claim 27., respectively, these claims limits claim 27 in essentially the same manner as claims 5 and 16, respectively. Therefore, with regard to claims 29 and 33, remarks analogous to those presented above, with respect to claim 5 and 16, are respectively applicable.

19. *The following is in regard to Claim 35.* As shown above, Hong et al.'s method of human face detection and tracking is digital image processing method that conforms to all aspects of the method claimed in Applicant's claim 27. Note that the limitations of claim 35 are essentially the same as those set forth in claims 25 and 26. Therefore, with regard to claims 35, remarks analogous to those presented above, with respect to claim 25 and 26, are applicable.

Rejections Under 35 U.S.C. § 103(a)

20. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

21. Claims 2 and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hong et al., in view of Dufaux (U.S. Patent 6,711,587).

22. *The following is in regard to Claim 2.* As shown above, Hong et al.'s method of human face detection and tracking is digital image processing method that conforms to all aspects of the method claimed in Applicant's claim 1. In the method of Hong et al., the step of detecting a plurality of iris colored pixels in the digital face image, further includes:

b. Identifying a plurality of skin color regions. See, for example, Hong et al. column 11 lines 22-50, column 18 lines 40-45, column 19, 25-34 and S23 of Fig. 7.

c. Identifying a face region from the plurality of skin color regions. See, for example, Hong et al. column 11, lines 49-55 and Fig. 7, steps S23-S25.

d. Examining pixels in the face region to detect the plurality of iris colored pixels. See, for example, Hong et al. column 6, lines 20-30.

Hong et al. do not, however, show or suggest that this step of detecting a plurality of iris colored pixels additionally include:

a. Performing a color histogram equalization of the digital face image based on a mean intensity analysis of the digital face image.

23. Dufaux discloses a technique for finding an image in a sequence of images that includes a person(s). This technique involves human face detection capable of detecting facial features (e.g. eyes and mouth). See Dufaux column 5, lines 44-46. Dufaux teaches that, in order to compensate for diverse lighting conditions and differences in camera gains, and to improve overall contrast, the image(s) may pre-preprocessed using histogram equalization. See Dufaux column 5, lines 34-38.

24. Dufaux and Hong et al. are combinable because they are analogous art. That is, generally, they attempt to solve a similar problem, namely detecting human facial features in a digital image(s). Therefore, it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to extend the human face detection/tracking method of Hong et al., so as to preprocess the digital image using histogram equalization, in the manner taught by Dufaux. The motivation/suggestion for doing so would have been to facilitate the detection (and subsequent location) of the various facial features, by eliminating spurious illumination effects and improving contrast (Dufaux column 5, lines 34-38). The methods of Hong et al. and Dufaux, when combined in the manner just described, yield a digital image processing method that satisfies all limitations of claim 2.

25. *The following is in regard to Claim 28.* As shown above, Hong et al.'s method of human face detection and tracking is digital image processing method that conforms to all aspects of the method claimed in Applicant's claim 27. Note that while the subject matter claimed in claim 28 is different than that which is claimed in claim 2 (due to its dependence on claim 27), claim 28 limits its parent claim (i.e. claim 27) in exactly the same manner. Therefore, with regard to claim 28, remarks analogous to those presented above with respect to claim 2, are applicable.

26. Claim 3 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hong et al. and Dufaux, as applied above, in further view of Gonzalez and Woods ("Digital Image Processing", Section 9.3.2: Optimum Statistical Classifiers, pp. 586-595).

27. *The following is in regard to Claim 3.* As shown above, the teachings of Hong et al. and Dufaux can be combined to satisfy all the limitations of claim 2. Furthermore, in the aforementioned method of Hong et al., the step of examining pixels in the face region to detect the plurality of iris colored pixels includes: (a) measuring a red intensity of the pixel. This is suggested, for example, in step S10 of Fig. 14 of Hong et al. However, neither Hong et al. nor Dufaux show or suggest applying a probability analysis to classify the pixel as iris colored.

28. Bayesian classification or Bayesian clustering is a well-known and often-used probabilistic means to cluster, partition, and/or classify image data (and a myriad of other types of data) according to a specified set of features (or, using the nomenclature of Gonzalez and Woods, *unknown patterns*). See, for example, the last paragraph on page 586 of Gonzales and Woods. Gonzalez and Woods illustrate a specific application of Bayesian classification to digital image data in the example given on pages 592-595.

29. The teachings of Hong et al. and Dufaux, combined in the manner discussed above, are compatible with the teachings of Gonzalez and Woods because each is directed and/or applicable to the processing of digital image data. Therefore, having prior knowledge of the color properties of irises (or pupil region), it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to use Bayesian classification to assign each pixel of the digital image to a class (cluster) ω_i, among a plurality of classes $\{\omega_k \mid k = 1 \ldots M\}$ (clusters) according to their color (i.e. unknown pattern $\boldsymbol{x}$ – see pages 586-587 of Gonzalez and Woods), where one class corresponds to the known color properties of the iris (or pupil region), thereby detecting the plurality of iris colored pixels (e.g. eye pupil regions – column 6, lines 33-35 of Hong et al.). The motivation/suggestion to use Bayesian classification to classify pixels in this manner is that Bayesian Classifiers provide optimal classification (paragraph 1 of Section 9.3.2 on page 586 of Gonzales and Woods). By incorporating Bayesian classification into the method, obtained by

combining the teachings of Hong et al. and Dufaux, in the manner described above, one would obtain a method that satisfies the limitations of claim 3.

30. *The following is in regard to Claim 4.* As shown above, the teachings of Hong et al., Dufaux and Gonzales and Woods can be combined to satisfy all the limitations of claim 3. Bayesian classifiers are based on Bayes' rule. See equations (9.3-9) to (9.3-12) and paragraphs 2-4 on pages 586-587 of Gonzalez and Woods. Clearly, the subject matter claimed in claim 4 is addressed by the discussion above. Therefore, the method derived from combining Bayesian classification, in the manner proposed above, with the aforementioned combination of Hong et al. and Dufaux, is such that the step of applying a probability analysis comprises the step of applying a Bayesian model. This combination thus satisfies the limitations of claim 4.

31. Claims 6 and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hong et al., in view of Chen et al. (U.S. Patent Application Publication 2002/0136450).

32. *The following is in regard to Claim 6.* As shown above, Hong et al. teaches a method that satisfies the limitations of claim 5. While Hong et al. do show the measurement of the vertical and horizontal dimensions of eye regions, their method does not include a step of validating the iris pixel clusters comprising the steps of:

(6.a.) Determining the height to width ratio of each iris pixel cluster; and

(6.b.) Invalidating the iris pixel cluster if the height to width ratio is greater than a pre-determined value.

33. Chen et al., on the other hand, disclose a method for the detection of an eye (red-eye) that includes a "validation" step, comprising the steps of:

(6.a′.) Determining the height to width ratio (i.e. aspect ratio) of each iris pixel cluster (i.e. pixel groups representative of candidate red-eye regions – Chen et al. column 3, paragraph [0026]). See paragraph [0031] in column 3 of Chen et al.

(6.b′.) Invalidating the iris pixel cluster if the height to width ratio is greater than a pre-

determined value (e.g. upper bound 2.0). See paragraph [0031] in column 3 of Chen et al.

34. Hong et al. and Chen et al. are combinable because they are analogous art. In particular, both attempt to solve the problem of identifying and locating regions of the image corresponding to the eyes of individual depicted in a digital image. Therefore, it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to validate pixel clusters according to steps (6.a′.) and (6.b′.) above, in lieu of, or in addition to the validation step proposed by Hong et al. and discussed above, relative to claim 5. The motivation/suggestion to do so would have been to provide a straightforward method in which to eliminate pixel clusters that do not correspond to the known spatial dimensions of the human eye. Combining the teachings of Hong et al. and Chen et al., in this manner, yields a digital image processing method that conforms to that which is claimed in claim 6.

35. *The following is in regard to Claim 8.* As shown above, Hong et al. teaches a method that satisfies the limitations of claim 1. However, the aforementioned step of grouping the plurality of iris colored pixels into clusters, as taught by Hong et al., does not comprise the step of determining whether each iris colored pixel is within a predetermined distance to another pixel in the iris pixel cluster.

36. The method of eye detection taught by Chen et al., discussed above, includes a *pixel grouper* (Chen et al. Fig. 2, reference number 132) that groups candidate pixels into the same group if their distance is no more than one, or, alternatively, if they are separated by some predetermined threshold distance. See Chen et al. column 2, paragraph [0025]. In other words, grouping according to Chen et al.'s method comprises the step of determining whether each iris colored pixel is within a predetermined distance to another pixel in the iris pixel cluster.

37. Hong et al. and Chen et al. are combinable because they are analogous art. In particular, both attempt to solve the problem of identifying and locating regions of the image corresponding to the eyes of individual depicted in a digital image. Therefore, it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to group candidate eye or iris pixels according to the teachings of Chen et al., in lieu of, or in addition to, the pixel grouping of Hong et al.'s method. The motivation/suggestion for doing so would have been to provide a simple method for *spatial* clustering of pixels. This, in turn, coarsely defines certain geometric structures in the image that may represent the

known geometric structure of the human eye. Combining the teachings of Hong et al. and Chen et al., in this manner, yields a digital image processing method that is in accordance with that which is claimed in claim 8.

38. Claims 15 and 32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hong et al., in view of Luo (U.S. Patent 6,151,403), in further view of Gonzales and Woods ("Digital Image Processing", Section 4.3.3, pages 196-197.

39. *The following is in regard to Claim 15.* As shown above, Hong et al. teaches a method that satisfies the limitations of claim 1. While Hong et al. teaches the step of identifying salient pixels, Hong et al. does not expressly disclose that such a step should comprise the steps of:

(15.a.) Morphologically smoothing the digital face image to generate a smoothed face image,

(15.b.) High-boost filtering the smoothed face image to generate a filtered face image, and

(15.c) Thresholding the filtered face image into a binary image having salient pixels

40. Luo discloses a method for detecting human eyes in a digital image that includes a step of identifying salient pixels within a *sub-image* of the face by morphologically smoothing the sub-image of the face (Luo Fig. 5 step S10a), deriving a valley or map (Luo Fig. 5 step S10b) and thresholding that image (Luo column 5, lines 23-25) to form a binarized map (Luo Fig. 5 step S10h) indicating the presence of salient features within the sub-image. See column 4, lines 45-67 to column 5, lines 1-25. It would be clear to one of ordinary skill in the art that the sub-image can be defined so as to encompass the entire face image (or, using Luo's nomenclature, the flesh region) without defeating the purpose of the said step of identifying salient pixels within a *sub-image*[2].

41. Hong et al. and Luo are combinable because they are analogous art. That is, both attempt to solve the problem of identifying and locating salient regions of the image corresponding to the face and, more particularly eyes the of individual depicted in a digital image. Therefore, it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to modify the method of Hong et

2 This would simply increase the scope of the search for eye locations.

al. so as to identify salient pixels in the input digital image in the manner proposed by Luo. The motivation/suggestion for doing so would have been to advantageously remove noise and illumination defects (via morphological smoothing – see Luo column 5, lines 2-6), flat flesh regions (via valley detection – see Luo column 4, lines 67) of the input image, and provide a binary mask for readily identifying candidate regions of the image corresponding to the eye (or other facial features).

42. Note that in order to remove flat features in the facial image (flesh region), Luo resorts to constructing a valley map. However, neither Hong et al. nor Luo show or suggest high-boost filtering the smoothed face image to generate a filtered face image.

43. High-boost filtering is a well-known method of removing low-frequency regions (e.g. flat regions) of an image, thereby providing a rudimentary means to emphasize edges or other high-frequency regions of the image. It would be understood by one of ordinary skill in the art that such high-frequency regions contained in a digital image of a face would include prominent facial features such as the eyes and mouth. Gonzales and Woods show the application of high-boost filtering to digital images on pages 196-198. Note, in particular, the emphasis of high-frequency regions of an image and the suppression of low-frequency regions illustrated in Fig. 4.27 on page 198 of Gonzalez and Woods.

44. The teachings of Hong et al. and Luo, combined in the manner described above, are compatible with those of Gonzalez and Woods, relating to high-boost filtering because these teachings are analogous art. Each of these teachings is directed to the processing of digital images. In particular, the high-boost filtering taught by Gonzalez and Woods provides an alternate means to that which is proposed by Luo, of detecting and removing flat flesh regions of the facial image. Therefore, it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to use high-pass filtering as opposed to the valley detection of Luo, in the method derived from the combination of Hong et al. and Luo. The motivation/suggestion for doing so is that high-boost filtering, as taught by Gonzalez and Woods, provides more flexibility, with the parameter A (see equation 4.3.3 on page 196 of Gonzalez and Woods), to emphasize high-frequency regions and suppress low-frequency regions of the facial image. Combining the teachings of Hong et al., Luo, and Gonzalez and Woods yields a method that satisfies the limitations of claim 15.

45. *The following is in regard to Claim 32.* As shown above, Hong et al.'s method of human face detection and tracking is digital image processing method that conforms to all aspects of the method claimed in Applicant's claim 27. Note that the limitations of claim 32 are essentially the same as those set forth in claim 15. Therefore, with regard to claim 32, remarks analogous to those presented above with respect to claim 15, are applicable.

46. Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hong et al., in view of Funayama et al. (U.S. Patent Application Publication 2001/0014182).

47. *The following is in regard to Claim 19.* As shown above, Hong et al. teach a method that is in accordance with claim 18. Hong et al. do not, however, teach that the step of separating the digital face image into the upper half region and the lower half region comprises the steps of:

(19.a.) Determining a top boundary of the digital face image,

(19.b.) Determining a bottom boundary of the digital face image, and

(19.c) Determining a mid-point between the top boundary and the bottom boundary.

48. Funayama et al., on the other hand, discloses a digital image processing apparatus that includes the identification and location of various facial features (e.g. mouth and eyes) by inspection of horizontal and vertical histogram (integral) projections (e.g. Funayama et al. Figs. 22-26). This apparatus performs the following steps:

(19.a.) Determining a top boundary of the digital face image. This step is inherent to Funayama et al.'s determination of the *face-skin region* (Funayama et al. Fig. 10, reference number 10-2) within the input digital image and the determination of the *face mask* (Funayama et al. Fig. 19, reference number 17-6), which indicates the boundary of the face.

(19.b.) Determining a bottom boundary of the digital face image. This step is inherent to Funayama et al.'s determination of the *face-skin region* (Funayama et al. Fig. 10, reference number 10-2) within the input digital image and the determination of the *face mask* (Funayama et al. Fig. 19, reference number 17-6), which indicates the boundary of

the face.

(19.c) Determining a mid-point (Funayama et al. Fig. 27, reference number 26-7) between the top boundary and the bottom boundary. See, for example, Funayama et al. column 3 paragraph [0035] and column 9 paragraphs [0127], [0130], and [0132].

49. Hong et al. and Funayama et al. are combinable because they are analogous art. That is, both authors disclose methods of digital image processing involving the detection and location of various human facial features via histogram projections. Therefore, it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to augment the step of separating the digital face image into the upper half region and the lower half region, as taught by Hong et al., with steps (19.a)-(19.c), as taught by Funayama et al. The motivation/suggestion for doing so would have been to restrict the search of the various facial features to the area of the image between the top and bottom boundaries of the face and to further define the search space of specific facial features that would be local to the top and bottom regions of the face, delineated by the determined mid-point (e.g. eyes are searched for in the top region and the mouth search for in the bottom). This advantageously improves search accuracy and speed. Combining the teachings of Hong et al. and Funayama et al. in the manner proposed above would yield a digital image processing method that is in accordance with claim 19.

50. Claims 20, 22, and 34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hong et al., in view of Luo (U.S. Patent 6,151,403).

51. *The following is in regard to Claim 20.* As shown above, Hong et al. teaches a method that satisfies the limitations of claim 17. The step of finding peaks of the signature curve, in the method of Hong et al., further includes:

(20.a.) Separating the digital face image into an upper half region and a lower half region.

(20.c.) Finding the peak of the signature curve disposed within the lower half region.

See the discussion above with regard to claim 18 (steps (18.a) and (18.b)). Hong et al., however, does not show or suggest that step of finding peaks of the signature curve involve: (20.b) smoothing the signature curve.

52. Luo discloses a method for detecting human eyes in a digital image that includes the smoothing of a signature curve – in this case a histogram – prior to finding its peaks. See Luo Fig. 3 steps S4d-S4f. Note that an integral projection, such as that which is used by Hong et al., is a histogram.

53. Hong et al. and Luo are combinable because they are analogous art. Specifically, the teachings of Hong et al. and Luo are directed to the detection and location of facial features within an image depicting a human face. Furthermore, though the histograms of Luo and Hong et al. differ in their specific purpose and mathematical representation, the teachings of Luo relating histogram smoothing, and the purpose it may serve in facial feature detection, are still applicable to the method of Hong et al. Therefore, it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to smooth the signature curve of Hong et al.'s method (e.g. vertical or horizontal integral projections) prior to finding its peaks, as taught by Luo. The motivation/suggestion for doing so would have been that smoothing the histogram reduces noise, thereby eliminating spurious peaks that may otherwise have been falsely (or wastefully) detected. Combining the teachings of Hong et al. and Luo, in this manner, would provide a digital image processing method that conforms to the limitations of claim 20.

54. *The following is in regard to Claim 22* . As shown above, Hong et al. teaches a method that satisfies the limitations of claim 1. The step of using the signature curve and the eye positions to locate a mouth position, in the method of Hong et al., further includes the steps of:

- (22.a.) Locating a position midway between the eye positions. This is suggested in Hong et al. column 17, lines 48-51.
- (22.c.) Locating a bottom peak position (i.e. Y_P – Hong et al. Fig. 24) on the signature curve.
- (22.d.) Defining the bottom peak position as a vertical coordinate of the mouth. See Hong et al. Fig. 24.

Though it is clear from Fig. 24 that the peak X_P of the vertical projection is a horizontal coordinate of the mouth in nearly the same location of the midway position between the two detected eyes, Hong et al. does indicate that these positions are or should be the same. In other words, Hong et al. does not show or suggest: (22.b) Defining the midway position as a horizontal coordinate of the mouth.

55. In the method of Luo, on the other hand, the midway position between the eye positions is used as a horizontal coordinate of the mouth. See Fig. 10 of Luo.

56. Hong et al. and Luo are combinable because they are analogous art. Specifically, the teachings of Hong et al. and Luo are directed to the detection and location of facial features (including a mouth) within an image depicting a human face. Therefore, it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to use, in the manner of Luo, the midway position between the eye positions as a horizontal coordinate of the mouth, as opposed, or in addition to, the peak X_P of the vertical projection, in the method of Hong et al. The motivation/suggestion for doing so would have been that defining a horizontal coordinate using the midway position between the already derived eye positions is clearly easier than defining it as the peak X_P of the vertical integral projection. By combining the teachings of Hong et al. and Luo in this manner, one obtains a digital image processing method that conforms to the limitations of claim 22.

57. *The following is in regard to Claim 34.* As shown above, Hong et al.'s method of human face detection and tracking is digital image processing method that conforms to all aspects of the method claimed in Applicant's claim 27. Note that the limitations of claim 34 are essentially the same as those set forth in claim 22. Therefore, with regard to claim 34, remarks analogous to those presented above with respect to claim 22, are applicable.

Allowable Subject Matter

Objections, Allowable Subject Matter

58. Claims 10-14 and 31 and 36 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

59. The following is a statement of reasons for the indication of allowable subject matter.

60. *The following is in regard to Claims 10-13 and 31.* Prior art template-matching methods abound that determine the similarity between a given template and a cluster (or patch) of the image by measuring

the difference in pixel intensity (or color). Typically, the difference between the template and cluster is used as an indication of similarity. This difference is often measured by evaluating the sum of squared distance (as in claims 10 and 12) or the mean squared distance (as in claims 11 and 13). Such prior art methods would address the limitations set forth in Applicant's claims 10-13 and 31.

61. *The following is in regard to Claim 14.* Prior art methods do exist where the left and right portions of the face image are evaluated according to steps put forth in Applicant's claim 14. Fuyanama et al. (U.S. Patent Application Publication 2001/0014182), for example, would address the limitations of claim 14.

62. *The following is in regard to Claim 36.* Prior art methods were not encountered that meet the limitations of claim 31 and further employ an average eye generated by averaging a large number of sample eye images, as in claim 36. However, using mean characteristics of a large collection of template images for the purposes of comparison to an input image is well-known.

Allowable Subject Matter

63. Claim 7, 9 and 30 are allowed.

64. The following is a statement of reasons for the indication of allowable subject matter.

65. *The following is in regard to Claim 7.* Prior art methods were not found that invalidated a pixel cluster on the basis of the number of pixels constituting the cluster.

66. *The following is in regard to Claim 9 and 30.* Several prior art digital image processing methods were encountered that detected and located eye positions according to steps (a)-(f) of claim 9. Hong et al. is an example. Hong et al. also suggests the usage of templates situated in either the right or left portions of the image. Hong et al. also use windows of these regions as intermediate search regions. See Fig. 17A-17B of Hong et al. Though this is similar to steps (g) and (h), Hong et al. do not address the specific limitations of steps (g) and (h). Specifically, Hong et al. do not show or suggest centering the image patch on each pixel in the window. Similar arguments can be made for claim 30.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kevin Siangchin whose telephone number is (703)305-7569. The examiner can normally be reached on 9:00am - 5:30pm, Monday - Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Amelia Au can be reached on (703)308-6604. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

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Kevin Siangchin

Examiner
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ks – 04/09/04

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